North Creek Forest Irrigation System

Friends of North Creek Forest

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I. Introduction:

Friends of North Creek Forest (FNCF) serves as the care taking group for the North Creek Forest in Bothell, WA. The area includes 9 wetlands and 7 streams which acts as a giant filter for salmons, 64 acre of upland conifer and mixed forest. It is a home for many species such as Pileated Woodpecker, Douglas Squirrel, and over 110 native moss species. Furthermore, the forest is located in walking distance, it is truly a great asset for students K-PhD. Their mission is “to maintain and improve the biological function of North Creek Forest through education, stewardship and conservation in perpetuity.” With 42 acres has already been purchased, the organization wish to purchase the last 22 acres in the near future. Along with expanding in size, they also put an enormous effort to maintain the forest. Among the responsibilities of this care taking are watering new growth plant life. FNCF is seeking a solution that allows them to conveniently water these plant sites, using volunteered labor. The volunteers present some particulars that help define possible solutions.

The forest itself is on the I-405 corridor, and has sloped terrain. There are available fire hydrants as a water source that FNCF would like to utilize if possible. The nature of the organization results in a drive to keep costs down. Approximately 200 plants have to be watered at our restoration site. The top of the area is flat for the majority of it and there are nearly 100 of the plants on this top area. The remaining plants are all on the slope going down from the top of the sight, which we estimated the slope to be approximately 50 feet from top to bottom.

II. Problem Definition:

The city of Bothell provided FNCF a device to use water from the hydrant near by. The problem with the current way of watering is that only board members of North Creek Forest are allowed to water the plants now, but there are only two members and they would like it to be possible for all of the volunteers to be able to come and water without the presence of one of the board members. The purpose of this project is to find a way to water a small section of the North Creek Forest. Although this is the overall goal, we also have a couple smaller goals for this project. One of those is to make sure the method is inexpensive and easily implemented. Another important part to add is that we needed to design a system that would maintain the correct pressure across the whole system to make sure that each of the plants can get the water needed to survive.

III. Design/Solution:

Our original idea was to use a large water tank (approximately 500 gallons) to store water from the hydrant using the meter given to the North Creek Forest board, and then volunteers would be able to come and use that water in the tank on their own time to water the plants. After meeting with the city engineer, we all came up with a new idea that involved tapping into the water supply and having a meter installed to properly charge North Creek Forest, for their water use. This would avoid having a huge tank that could possibly cause problems with the neighborhood for any reason. In addition, having a metered connection will provide consistent water pressure. This would also achieve the goal of having volunteers be able to come on their own time to water the plants. With the water tap, anyone would be able to use it, without any board members being there to supervise. Also, the water pressure from the water tap would be sufficient enough to be able to water the plants from the tap. The cost of tapping into the water supply could be anywhere around $5000, but this would be a one time fee and would make a huge difference in the long run on the watering capabilities.

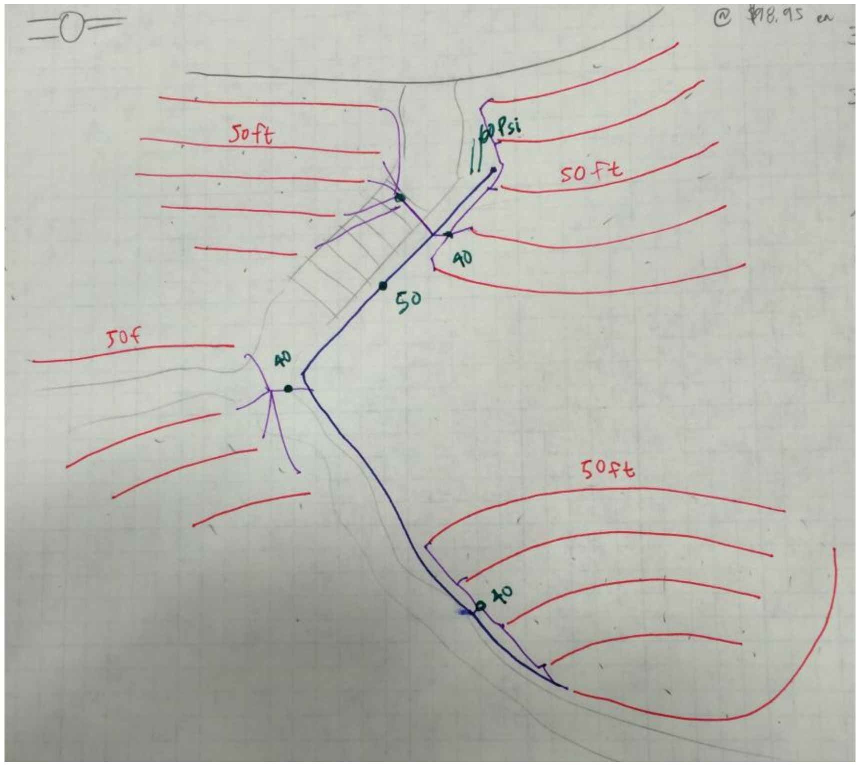

Figure 1: Water lines map

For now we have designed a system where a flexible ½ inch main line regulated to 30 psi at the start will run down the center of the area needing to be watered with 4 separate lines coming off of this main. The main line in the picture above can be seen as the dark blue line running down the middle. These four lines, labeled as the purple lines, will have attached to them, a ball valve to turn the water on and off to each section in case there is a problem of over watering due to rainfall (Some sections are covered by trees more than others). From these four lines with a ball valve connected, there will be five more separate drip irrigation lines coming off of those, labeled in red on the picture above. These five lines will each be about 50 feet in length and have emitters every three feet to water the plants. Below is a table of the overall materials needed and the cost associated with those materials.

Material	Count	Cost per item	Total cost
Tubing w/ emitters	1000 feet	$98.95/500 feet	$197.90
Main tubing	330 feet	$78.33	$78.33
Ball Valves(brass)	5	$7.60	$38.00
T-connectors	15	$2.76/4 pack	$11.04
In-line Pressure Regulator	1	$10.48	10.48

Total cost of all materials: $335.75

This table above only shows the total price of materials.

IV. Narrative:

When the project began, we anticipated using the sloped terrain to our advantage, as well as utilizing the hydrant that is already accessible. To do so, a water storage tank was going to be used, and would function like a water tower to provide water to plants below. The caveat is the filling of the tank, and the lack of mobility of a tank and corresponding structure should it need to be moved.

During this process, we met a Bothell City engineer Eddie Low, from which the idea of adding a service line was sparked. This was not a consideration of ours at the beginning of the project, but has come to be a much more practical thought. A service line would provide ample water pressure to water any of our sites, and would allow for volunteers to run water when available, rather than depending on a tank filled only by FNCF staff. It also presents the possibility of using timed meters to water plants at specific times and durations. This could lead to watering in summer evenings, when volunteers may be unavailable, and is an ideal time for spreading surface water to avoid undue loss to evaporation.

Returning to analyze our possible use of a water tank, to avoid the costs of installing a service line, it became apparent that the required elevation of a tank would only be feasible if we had a high central tank location. The irrigation lines have a minimum operating pressure of 7 psi, which is equivalent to 16 feet of head (Rain Bird). This means the water tank needs to be located at least 16 feet higher in elevation than the highest plants to be watered. This is not possible with the geography of the restoration site which has plants up by the water supply at the street. This would complicate Thus, we settled on a service line design, to remove possible usage headaches but provide much superior quality of service.

Having chosen our method, we needed to verify pressures in the system. This was required because of the large amount of pressure available from the main, which we felt required the use of a regulator to ensure safe operation. This also allowed us to lower the pressure at the top of the grade, while the grade itself would build more pressure in the lower part of the system, while remaining in a safe operating condition.

To best serve the sites to be watered, we elected for a branched system. A backbone waterline runs from top to bottom of the site. There are two branches off of the top of the line, and two at lower points of the line. Setting up the system in this fashion allows for specific branches to be turned off. This would be useful during times of partial rainfall when the lower levels may receive too much water if the system to were run at the same time as the upper sites. It also allows the branches to be changed without interrupting the entire system.

V. Conclusion:

The actual routing of the waterlines is the main contingency of our plan. The length of material required depends on the routes chosen, and will affect the cost of the project. Our plan calls for a specific arrangement of irrigation piping to serve the sites. We are using flexible piping for maximum compatibility with the various landscapes in the forest. It is possible to arrange this in a different fashion, should the needs of the forest require. As mentioned above, the total cost would be anywhere around $5000 and this total can be more approximated upon request. This was just a simple estimate by an engineer we met with and he directed us to a colleague of his for a more exact price and we are waiting to hear back from him hopefully soon.

References
http://www.friendsnorthcreekforest.org/
http://www.rainbird.com/documents/ag/ts_A5PC.pdf

Links for materials priced

- http://store.rainbird.com/drip-low-volume/fittings-stakes-connectors/bt50-4pk-1-2-in-barbed-drip-tee-4-pack.html
- http://store.rainbird.com/drip-low-volume/dripline-blank-tubing/spxflex330-1-2-in-flexible-swing-pipe-330-ft-coil.html#product_tabs_additional_tabbe
- http://www.amazon.com/Dixon-Valve-Coupling-FBVG50-Female/dp/B00CSYD8SC/ref=sr_1_1?ie=UTF8&qid=1449437613&sr=8-1&keywords=brass+ball+valves
- http://www.dripworks.com/product/Q_DET361
- http://www.sprinklerwarehouse.com/Rain-Bird-Sprinker-Inline-Pressure-Regulator-p/psi-l30x-075.htm

Appendix

Point of connection #1 elevation change ≈ 0 ft
Point of connection #2 elevation change ≈ 30 ft
Point of connection #3 elevation change ≈ 50 ft

Input pressure will be regulated to 30 psi to ensure that pressure of the system is between 7 psi and 60 psi throughout the system. Pressure Drop due to 50 ft drip line = 0.2 psi

No data for our "back bone" piping so using data for piping with the fewest emitters.

P.O.C #1 located after 50 ft of backbone line.
Pressure Drop due to backbone = 0.14 psi
Pressure Due to elevation change = 0 psi (0 ft)
Pressure @ POC #1 = 30 psi − 0.14 psi + 0 psi = 29.86 psi
Pressure @ end of drip lines by POC #1 = 29.86 psi − 0.2 psi = 29.66 psi

POC #2 located after 150 ft of Backbone line
Pressure Drop due to Backbone = 0.44 psi
Pressure Due to elevation change $= 30\,ft \times 0.4335\,\frac{psi}{ft} = 13\,psi$
Pressure @ POC #2 = 30 psi − 0.44 psi + 13 psi = 42.56 psi
Pressure at end of drip lines = 42.56 psi − 0.2 psi = 42.36 psi

Pressure drop due to backbone @ POC #3 = 0.88 psi
Pressure due to elevation change $= 50\,ft \times 0.4335\,\frac{psi}{ft} = 21.68\,psi$
Pressure @ POC #3 = 30 psi − 0.88 psi + 21.68 psi = 50.6 psi
Pressure @ end of dripline = 50.6 psi − 0.2 psi = 50.4 psi

Pressure is always above 7 psi (the min. operating pressure) and below 60 psi (the max operating pressure)

flow rate $= 1.06\,\frac{Gallons}{hour \times Emitter} \times \frac{1\,Emitter}{2\,feet} \times \frac{50\,ft}{line} \times 16\,Lines = 424.0\,\frac{gallons}{hour}$

$424\,\frac{G}{hr} \times \frac{1\,hr}{60\,min} \times \frac{1\,min}{60\,sec} = 0.11778\,\frac{Gallons}{second}$